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THE SOCIALIZATION OF
THE ELECTRICAL SUPPLY
INDUSTRY

THE SOCIALIZATION OF THE ELECTRICAL SUPPLY INDUSTRY

by

G. H.

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AUTHOR'S NOTE

THIS SURVEY of the electric supply industry is published under the auspices of the New Fabian Research Bureau, but the author wishes to make it clear that he alone is responsible for the views expressed. The conclusions reached, and the proposals put forward, however, are substantially similar to those in the *Labour Party Policy Report, No. 3*—"Reorganization of the Electric Supply Industry"—although there are a number of differences, mainly in detail. The author has made use of many publications and documents on the subject, some of which are acknowledged in the book; the others he begs to acknowledge here. He also wishes to thank Herbert Morrison and all those who kindly read the original draft, and who supplied many valuable criticisms and suggestions.

G. H.

ELECTRIC SUPPLY IN GREAT BRITAIN

THE OBJECT of this book is to sketch briefly the history of electric supply in this country, concentrating more particularly on the history of the last six years, to describe the present position, and to suggest the most suitable future organization of the industry under public ownership.

EARLY HISTORY

The history of electric supply in Great Britain dates from about the 'eighties. Prior to this, electricity was mainly or entirely in the realm of pure science, and was associated with such names as Faraday, Maxwell, and Kelvin. Actually the first public supply was given in Godalming, Surrey, in 1881, although before this date there had been installed a number of private lighting installations—largely experimental and semi-scientific in character. The use of electricity for lighting purposes became a practical possibility with the invention of the carbon-filament lamp by Swan in this country,

about 1880, and Edison in America shortly afterwards ; but electric motors for power purposes did not become commercially practicable till much later, and consequently all the earlier Acts of Parliament dealing with electric supply were termed Electric Lighting Acts. The first of these Acts was the 1882 Act, and this and subsequent Acts gave the necessary powers to private enterprise to provide lighting supplies to the public. These powers were, however, subject to severe restrictions. In the first place, local authorities were given the right to purchase the company undertakings after a certain term of years, and, in the second place, Parliament, on general principle, tried to secure the supposed advantages of competition between companies who were not therefore given complete monopolies. The latter restriction imposed by Parliament was in accordance with the then widely accepted view that a system of competitive private enterprise without monopoly resulted in the best service to the public. In practice the effect of the restrictions was greatly to hamper the activities of the companies and to lead to wasteful competition. This experience in the electric supply industry was

typical of the breakdown of the old doctrine of *laissez faire*.

The second stage of electric supply legislation is largely concerned with attempts to remedy these difficulties and to give the companies greater security and greater monopoly rights. In 1898 Lord Cross presided over a Select Committee of both Houses, and reported in favour of legislation permitting the existence of power companies serving large areas and having wide monopoly powers with security of tenure. Such legislation was desirable from a technical point of view, and also to facilitate a more rapid development under private enterprise. As the result of the Cross report, a number of private Acts were passed, creating large power companies, with the right to give supplies in bulk over wide areas, and not subject to purchase by local authorities after a term of years, but this and subsequent legislation was to a large extent only a compromise, and Parliament failed fully to recognize the two main essentials for electric supply—namely, monopoly and encouragement of large-scale operations. It seemed almost as though Parliament foresaw the political problems

which were bound to arise if such monopoly rights were given on a large scale to private enterprise. In the meantime the number of local authority undertakings was rapidly increasing, the total being 327 by 1916 as compared to 230 companies. These local authority undertakings for the most part served comparatively small areas, were subject to hampering restrictions, and, like most of the companies, tended to adopt a parochial outlook on electric supply.

This was the position up to the beginning of the War, but the latter showed very definitely both the weakness of electric supply in this country and its enormous importance. The position in the London area was particularly bad, since the numerous comparatively small companies and local authority undertakings holding rights of supply in various districts, and completely lacking in standardization, could not agree on any policy of unification.

1919 ACT

As a result of the Coal Conservation Committee's recommendation of a wide scheme of electrical reorganization and reconstruction, a

committee was appointed in 1917, under the chairmanship of Sir Archibald Williamson (later Lord Forres), and reported in favour of a national scheme of electrification under a central authority, which was to have power to create regional electricity authorities. In view of this report, a Bill was introduced in 1919, setting up the Electricity Commissioners, and giving them wide powers of control over the whole supply industry, and, in particular, the power compulsorily to create joint electricity authorities throughout the country. These joint electricity authorities would have been semi-public, non-profit-making bodies, controlling and operating electric supply over wide areas. Had this Bill been passed in its original form, the whole subsequent history of electric supply in this country would have been altered. As it was the House of Lords struck out the compulsory powers, and the Bill was then passed. The result was the creation of a central authority, the Electricity Commissioners, having certain rather negative powers—for instance, powers to veto the extension of generating plant—and having certain more or less judicial powers—for instance, to hold

enquiries for the purpose of extending existing areas of supply or granting new areas by means of Provisional or Special Orders—but with no positive powers to co-ordinate the whole industry. Joint electricity authorities could be formed, but only by voluntary amalgamations of the various interests in each area. During the period up to 1925 only one such authority was formed.

The action of the House of Lords definitely delayed the whole progress of electric supply by a matter of some seven years—or, that is, till the passing of the 1926 Act. This Act marks a very definite milestone in the history of electric supply in this country, and, in all probability, is the first step in the transition from private enterprise to public ownership for the whole supply industry. In view of the very great importance of the 1926 Act it is desirable to describe the circumstance in which it came into existence.

WEIR REPORT

After the mutilation of the 1919 Bill by the House of Lords, a further Act was passed in 1922, somewhat extending and modifying the crippled 1919 Act, and making certain

provisions for supplies to railway authorities, but not restoring the vital compulsory power. Nothing further happened till the advent of the 1923-24 Labour Government, despite the continued efforts of a few individuals. The Labour Government were keenly interested in the reorganization of the electric supply industry, and a Cabinet committee was in process of preparing a scheme when the Labour Government ended its short life. Fortunately the importance of this work was recognized by the succeeding Conservative Government under Mr. Baldwin, and a committee, presided over by Lord Weir, was appointed in 1925. This committee, to some extent starting from the 1917 report of the Williamson (Forres) Committee, made a general survey of the national problem of electric supply. In the opening paragraphs of their report, they state : " We are also bound to add, without necessarily subscribing to-day to the exact recommendations of the earlier committee, that if effective legislative action had been taken on the general lines of the recommendations of the Williamson Committee, very substantial savings would have been made. Electricity would

have been cheaper, and our task would have been infinitely easier and possibly unnecessary." Just how much the action of the House of Lords cost the country will, of course, never be known, but the figure, on even a most conservative estimate, must have been enormous.

The final report of the Weir Committee differs from that of the previous committee mainly in the recommendation that one national body, rather than several area bodies should be created to deal with generation and main transmission. This change was largely on account of technical developments during the period 1919-25, which had tended to increase the size of area within which co-ordination and interlinking were practical and desirable to the point where the optimum area became virtually the whole country. No doubt the regional boards, recommended by the Williamson Committee, had they ever come into existence, would have automatically tended to coalesce for the same reason. There is also another very important difference between the two reports. Whereas the Williamson report recommended area boards (joint electricity authorities), the function of such

boards was not wholly confined to generation and transmission, i.e. wholesale supply. It was possible for them, under certain conditions, also to carry out distribution, i.e. retail supply.

In the course of their report, the Williamson Committee stated :

“ We have already touched on the subject of distribution ; but we think it well to state our opinion that, if the supply of electricity were being commenced *ab initio*, it would be found best for generation and distribution to be conducted by one and the same body.”

The Weir report, on the other hand, confined its attention wholly to generation and transmission and states : “ The detailed distribution of electrical energy—in other words its sale, transport, and delivery—is essentially a local matter, and a suitable function for decentralization.” Elsewhere the report states : “ We do not desire to impair or interfere unnecessarily with existing rights ” ; and, “ We propose not a change of ownership, but the partial subordination of vested interests in generation to that of a new authority for the benefit of all, and this only under proper safeguards and in a

manner which will preserve the value of private enterprise." It is perhaps unnecessary to quote the report at further length to show, as can well be imagined, that the committee, while anxious to effect a substantial improvement in the organization of the industry, were afraid that, unless the proposals were confined to the minimum of interference with existing vested interests, any Bill based on their report would suffer the unhappy fate of the 1919 Bill. Subsequent events proved that the committee were very wise in confining their considerations only to the most pressing problem. The Bill finally introduced on the basis of their report was sufficiently disturbing to the vested interests to make its passage very perilous.

It is desirable at this point to give a brief summary of the scheme proposed by the Weir Committee, and its advantages, as anticipated in 1925, and now being realized by the work of the Central Electricity Board.

For the year on which the figures in the Weir Report are based, there were 438 generating stations (excluding 103 stations owned by railway and tramway companies and

non-statutory undertakings), of which 248, generating about 3,000 million units, were owned by local authorities, and 190, generating about 1,600 million units, by companies. Many of these stations were small and inefficient, and as they were mostly independent of each other, i.e. not connected together by electric cables, each had to carry a large reserve of plant in order to ensure continuity of supply in the event of a breakdown. This resulted both in high cost of operation and in heavy capital expenditure on plant. The Weir report proposed, therefore, a "gridiron" (since contracted to the now familiar word "grid") of high-voltage electric transmission lines, which would link together all these stations, thus allowing the less efficient stations gradually to be closed down, and generation to be concentrated in the newer, larger, and more economical stations. Moreover, the amount of spare or reserve plant could also be greatly decreased, because simultaneous breakdowns in several stations are highly improbable, and the existence of the transmission-line system allows reserve plant at any station to be used for supplying any other station. A further very important advantage

of the grid lies in the fact that it makes available bulk supplies of cheap electricity anywhere they are required. These are the principal advantages, though there are also others, such, for instance, as the advantage from diversity, i.e. the fact that the maximum load does not occur quite simultaneously in all parts of the country.

The only technical difficulty, existing in 1925, hindering the creation of the grid was the fact that the frequency of generation differed in different parts of the country. While generation in most parts of the country was at 50 cycles per second, there were large areas, notably the north-east coast, Glasgow, and Birmingham, where other frequencies were in use. This non-standardization was partly inevitable in a comparatively young industry, and partly the result of the haphazard development in the past. With a view to dealing with standardization of frequency the Labour Government of 1924 had called for a report from the Electricity Commissioners on the cost of standardization, and this report, prepared by consulting engineers acting for the Commissioners, was available for the Weir Committee

after the fall of the Labour Government. The Weir Committee very boldly—and for this much credit is due to them—proposed, despite the heavy cost involved, that the non-standard areas should be changed over to standard 50-cycle frequency. This has since been largely accomplished, though the work is not yet quite completed.

To construct the grid, and to control its operation and that of the efficient “selected” stations, the Weir Committee proposed the creation of a central authority called the Central Electricity Board. This body was to be independent, but related to the then existing central authority created under the 1919 Act—the Electricity Commissioners. The relationship between the two bodies was somewhat complex, but, roughly speaking, the function of the Commissioners in relation to the Board was largely judicial. Such a judicial function, including also the collecting of statistics and the laying down of regulations relating to safety in the industry, had, indeed, become to a large extent the actual general function of the Commissioners prior to the report, shorn as they were of the powers which might have

allowed them to exercise more positive or executive functions. This is a somewhat important point which requires to be borne in mind when later in this book the present position is considered.

1926 ACT

These main proposals of the Weir Committee were in due course embodied in a Bill, introduced in 1926, and termed the Electricity Supply Bill (1926). Although introduced by a Conservative Government, its passage through the House was difficult, and undoubtedly it would never have reached the statute book but for two reasons. Firstly, it interfered as little as possible with existing vested interests, and, secondly, it had to a large extent the support of the Labour members. During the committee stage it was fiercely attacked by Conservative back-bench members, representing vested interests, and wrecking amendments were on several occasions defeated by an alliance between the Government and the Labour members of the committee. A violent campaign against the Bill was conducted in the Press and elsewhere, and the Association of Electric

Power Companies, representing fifteen of the largest and most influential supply companies, published, in March 1926, a memorandum hostile to the whole principle of the Bill. It must also be recorded that there was very considerable criticism and opposition from the municipal authorities owning supply undertakings. However, the Bill was eventually passed, though it was touch and go—the Weir Committee had indeed estimated very exactly, and without any margin, just to what extent interference with vested interests was possible.

The Act which emerged from the turmoil provided for the creation of the Central Electricity Board, consisting of a chairman and seven other members appointed by the Minister of Transport after consultation with the various interests concerned in electric supply. The duties of this Board were to construct and operate the grid, and to control the operation of the efficient “selected” power stations. These stations, however, continued in the ownership of the existing undertakings, though they had to operate to the Board’s instructions ; the latter being responsible for all operating charges and required to sell back to the owners, at the

cost of production plus a charge to cover the Board's expenses, such amounts of electricity as the owners might require. This somewhat complicated arrangement was, of course, the result of the principle of "minimum interference," and would not have been necessary had the Act been more far-reaching. The less efficient "non-selected" stations could demand supplies from the grid, but, if so, the Board had power compulsorily to close them down, provided it could be shown that the cost of supply from the grid was, over a period of seven years, less than the cost of independent generation. This power was subject to certain limitations, which will be referred to later.

The grid was constructed according to area schemes (there are nine such areas, covering practically the whole country, though two of the areas are now virtually merged), and it is interesting to note that these schemes were first prepared by the Electricity Commissioners and then adopted by the Board. In the original Bill the schemes were to be submitted by the Board to the Commissioners, but in committee stage this was altered to transmitted by the Commissioners to the Board.

The nine grid areas are as follows :

Central Scotland	Mid-East England
South Scotland	{ South-East England
North-East England	{ East England
North-West England	South-West England
Central England	

In addition to the construction and operation of the grid, the Board had to provide, by arrangement with the undertakings, for the standardization of frequency. Financially, this was, however, a separate matter from the construction of the grid. For the latter purpose the Board had to raise loans, with or without Treasury guarantee, the interest charges on which had to be met out of revenue accruing from the operation of the grid. The cost of frequency standardization, on the other hand, was met by a turnover tax on all the existing undertakings in the country. As regards the loans for the construction of the grid, there was provision in the Act for the suspension of sinking fund and the payment of interest out of capital for a period of five years. In any comprehensive schemes of electrical development, there is inevitably a considerable period during

which little or no return is obtained on capital expenditure. This is an important point, which will be referred to later in connection with distribution.

The foregoing is a very brief outline of the main provisions of the 1926 Act. Although it gave to the Central Electricity Board the most essential powers, there were limitations to these powers which have considerably hampered the Board's operations. These limitations were for the most part imposed, not in the interests of the public, but to placate vested interests at the time the Act was passed. The most serious limitations arise in the following manner. A non-selected station taking a supply from the grid can only be shut down if it can be shown that the cost of the grid supply over a period of seven years is less than the present cost of generation. This sounds reasonable, but, in making the comparison, it is laid down in the Act that no account shall be taken of charges on the capital expenditure of the undertaking. In other words, the comparison is between the grid price, which, of course, includes charges on capital expenditure, with the bare operating cost of the undertaking, excluding such similar

charges. Such a comparison would only be reasonable *before* the grid is constructed. After construction the capital charges on both the grid and the undertaking's plant are inevitable in any event, and therefore it would be in the national interest for the supply to be given from the grid if, as would almost always be the case, the operating cost of the grid (i.e. the bare cost of current excluding capital charges) is less than that of the undertaking.

A further limitation on the operation of the grid arises from the necessity under the Act of declaring a uniform grid tariff for each area. It is difficult to frame such a tariff, because, in order to be able to supply undertakings owning moderately efficient stations, the tariff must necessarily be low. If low, other undertakings owning very inefficient stations, or owning no stations, get their supplies excessively cheaply, and it is difficult for the Board to cover their operating cost. Conversely there are instances where it may be desirable, for special reasons, to give supplies below the grid tariff. A company undertaking would, of course, give bulk supplies at the highest price which could be obtained in each instance. While not suggesting

that the company policy is desirable as a national policy, it is clear that so long as the Board has virtually to compete with the companies the former is at a disadvantage if it cannot use the methods of the latter.

Undoubtedly some of these limitations require urgently to be dealt with if full use is to be made of the grid, but a more important defect in the Act lies in the fact that it contains no adequate provision to secure to the general public the benefit of economies effected. It is true that there is provision for a revision by the Electricity Commissioners of the prices charged by the undertakings, or a relating of these to dividends, but the basis of such revision is not clearly defined, nor is it obligatory on the Commissioners to take action. Now, as has already been mentioned, the Commissioners duties are largely judicial, and, having developed the judicial outlook, they are little inclined to play the rôle of public prosecutor. Consequently, except by pressure of public opinion, there is no assurance that the general public will benefit fully as the result of the grid. Even more serious is the fact that there is no power to force the undertakings to adopt a progressive

policy and to make supplies available throughout their areas at reasonable prices. The absence of such powers, not only penalizes the public, but makes it impossible to utilize the grid to its full capacity. This, however, touches on the general problem of distribution, and will be dealt with later.

THE CENTRAL ELECTRICITY BOARD

The members of the Board were appointed in 1927, and the chairmanship was given to Sir Andrew Duncan, a barrister who had previously served on various committees and royal commissions, and was Coal Controller after the War, and, later, Vice-President of the Shipbuilders' Federation. The construction of the grid was immediately pressed ahead with the greatest possible speed, the Central Scotland scheme being the first to be commenced. Several decisions of fundamental importance were taken, notably the following :

(1) It was decided not to make use of the Treasury guarantee, but to raise money on the Board's own security, and so keep the Board clear of Treasury control. This decision, though

it involved difficulty, has been adhered to ever since, and is of great importance, because it has thus been possible to prevent the Board becoming merely a Government department. From the very commencement of the Board's existence this policy has been stressed, and its success will probably allow the organization of the Central Electricity Board to be taken, in many respects, as a model for similar bodies which may be created in the future. It is worth noting that the Electricity Commissioners, because they came into existence before new ideas of public administration had been conceived, have not avoided the characteristics of the Government department.

(2) It was decided to get the grid constructed and connected to all the principal stations before necessarily entering into definite arrangements with the various undertakings for giving or taking supplies.

(3) In adopting schemes, it was decided to resist the objections raised by undertakings in densely populated areas to forming part of areas covering sparsely populated regions. Thus the North-West England scheme covers the dense area of Lancashire and the sparsely populated area of Cumberland and North

Wales, despite the desire of some of the Lancashire undertakings to have an area of their own. The principle here adopted is similar to that of the uniform postal rates adopted by the Post Office.

(4) It was decided at all costs to get the grid constructed quickly, and not to invoke more than absolutely necessary the slow machinery of compulsory powers to acquire wayleaves. This policy may have involved extra cost, but largely achieved its object.

(5) The policy of co-operating to the fullest possible extent with existing authorities—the Post Office, the Air Ministry, local authorities, railway companies, etc., and even such non-statutory bodies as the Farmers' Union and the Council for the Preservation of Rural England—was adopted. This policy was naturally not without its difficulties, and sometimes clashed with (4).

(6) From the very first the problem of public amenities was given much consideration, both in the design of towers and in the routes of lines. To some extent a compromise was inevitable between such considerations and engineering and economic considerations.

Moreover, the result was not always satisfactory, as, for instance, when nearly a year was lost in the construction of the lines on and around the South Downs, largely due to differences of opinion between the various local bodies. Similar trouble was experienced in the Lake District, but, broadly speaking, the policy was successful.

(7) In the earlier period every effort was made to placate the opposition of the vested interests, whose hostility was very great after the passage of the Act. The means of doing this were numerous, but perhaps the most effective was by personal contact, particularly between the chairman and members of the Board and the representatives of the interests, and also between the Board's engineers and those of the undertakings. At a later stage, area consultative committees were formed, representing all the undertakings in each area, together with a similar national consultative committee. These steps were effective, and hostility greatly diminished, particularly from the municipal authorities. The Board gradually became accepted as a vital part of the electric supply industry, but, as its position became more assured, so too did its attitude

stiffen towards those vested interests which were irreconcilably hostile, and which hampered the Board's operations.

THE GRID

The above are some of the main points of general policy characterizing the Board's activities. As regards the actual engineering and construction of the grid, there were many difficulties to face. In the first place no high voltage work (132,000 volts) had, up to 1927, been carried out in this country, nor had British manufacturers much experience in the manufacture of such apparatus. By close investigation of experience abroad—America, Germany, Switzerland, Italy, etc., and some of the Dominions—where high-voltage transmission had been developed to some extent, and by obtaining the best technical advice available in this country, the various problems were gradually dealt with. Some of these problems were, however, peculiar to the circumstances in this country, and had to be settled without the aid of experience abroad. It is no small tribute to the technical staffs of the engineers and manufacturers—both design and

construction—that the grid has been completed and put into operation without, at least up to the present, any major mistakes having been made. Such errors as have been discovered have almost all been of a quite minor nature, and, because of central co-ordination, any defects discovered in one area have at once been rectified before they developed in other areas. For the same reason it has been possible to carry out experiments on new types of apparatus and more economical designs. In general, technical progress has undoubtedly been immensely more rapid than would ever have been possible under independent private enterprise. British manufacturers have probably now got experience in the manufacture of high-voltage apparatus which is in advance of that of any other country in the world.

As regards cost, the whole grid has been constructed, allowing for extensions not included in the original proposals, for very nearly what had been estimated in the Weir report, but, of course, in the later stages the general price level had fallen substantially. This occurred, however, after the bulk of the contracts had been placed. Very large economies have

been effected merely by the large-scale operations of the Board. Had the grid lines, or their equivalent, been gradually constructed piecemeal by private enterprise, the total cost to the country would inevitably have been very much greater. The cost of electrical equipment is, of course, liable to be affected by attempts on the part of manufacturers to make large profits through "ring" prices. Some of these attempts have, from the manufacturers' point of view, been successful, and quite a number have failed because of internal weaknesses in the ring associations. Amongst those which have succeeded are the cable makers' and switch-gear makers' rings, which have been in operation for many years, while that attempted by the transformer makers had until quite recently been less successful. In the latter case the failure to maintain ring prices probably resulted in excessive competition, for some time forcing prices down below an economic value. It is worth remarking that associations of manufacturers, even if they do result in higher prices, are not wholly undesirable. If properly organized, they may result in substantial economies to the manufacturers and to a proper

sharing of orders, which prevents violent fluctuations of employment in any particular works. If such associations go no further than fixing prices at high levels, they are, of course, wholly objectionable ; but if, as in the case of the Cable Makers' Association, they go much further and include organized research, pooling of patents and knowledge, they are definitely desirable in the public interest, provided there is some restriction on excessive profits. Whether, under conditions of private enterprise, such restriction of profits is possible is another matter.

STANDARDIZATION OF FREQUENCY

The cost of the standardization of frequency has been much heavier than had been estimated by the Weir Committee. This is mainly due to the fact that the Weir Committee estimate was based on a survey made in 1924. The actual work was not in progress till some six or seven years later, and in the meantime the amount of apparatus of all sorts which had to be converted had very greatly increased. The cost, as already stated, falls on the industry

as a whole, and is not part of the Board's expenditure on the grid. Although very costly, there can be no doubt that it will prove to be a sound investment, both because of economies thus made possible through the grid, and by economies in the future manufacture of standard frequency apparatus. It must be realized that electricity supply is still only in its early stages, and what seems costly to-day will in a few years' time be a negligible proportion of the total capital investment in the industry. For the same reason, if the standardization had been postponed, and, as is probable, had become imperative at a later date, the cost would have been immensely greater.

PRESENT POSITION

The grid is now virtually completed, or, as is probably more correct to say, it has reached a more or less steady state of expansion. The original schemes are completed, but extensions are in hand, and will always be in hand as far ahead as it is possible to see. The stage has been reached when, as visualized by the Weir

Committee, the existence of a network of transmission lines makes it possible to obtain a cheap supply of power wherever required. Such new supplies are being asked for, and are being given by the Board, and this is involving the construction of new transforming stations and other work. These new supplies are mainly being given in the areas towards which industry is tending to migrate—that is to say, in the southern districts. As from the beginning of 1934 the grid has been in full operation, in accordance with the terms of the 1926 Act, over most of the country. Certain areas, particularly Central Scotland, have been in full operation for some time past, and others have been in operation under temporary arrangements, and already substantial savings in operating costs have been made. Much the largest saving is, however, in the capital cost of generating plant, and on this score alone the whole cost of the grid—some 30 million pounds—will in all probability have been repaid within the next ten years. During the past twelve years the average annual installation of new generating plant sanctioned by the Electricity Commissioners was about 515,000 kw. Even allowing

for the effect of the depression the figure for recent years would, in the absence of the grid, have been at least 500,000 kw. With the approaching completion of the grid the figure fell to 153,000 kw. in 1931-32, and to 67,000 kw. in 1932-33, which represents an average annual saving of at least £5,000,000. Annual savings of this order of magnitude are likely to continue indefinitely, so that the whole cost of the grid and the frequency change will be wiped out in some ten years. To say this, does not, however, mean that the cost will be repaid to the Board. The bulk of the savings, both in operating costs and particularly in capital costs, accrue not to the Board, but to the existing undertakings, who may or may not hand them on to the public in full. Some of the difficulties with which the Board is faced under the terms of the Act have been mentioned, and it may be some time before the latter's financial position is finally assured, unless, in the meantime, certain amendments to the Act are made. The saving to the country is, however, undoubted, and it is correct to say that the problem of generation and main transmission—the wholesale side of the electric supply industry

—has been effectively dealt with. No doubt further improvements, both in technical matters and in actual organization of the Board, will be made in course of time, but there is nothing now to hinder such developments.

The above is no doubt very satisfactory from the point of view of electric supply, but there is another and much less pleasing side to the present situation. In carrying through this great work of construction, involving an expenditure of some 30 million pounds (or between 40 and 50 including the frequency change) in six or seven years, a very large number of persons has been employed directly or indirectly. The construction work is now mainly completed, and all the firms concerned have consequently had to effect drastic reductions in staff. Large numbers of workers of all kinds—some very highly trained engineers—are consequently being thrown out of employment. On top of this, the very fact of the success of the grid, particularly in saving expenditure on new generating plant, is further adding to unemployment. The present position is that on the construction side of the heavy electrical

engineering industry there exists a producing capacity which is not now being used, and which will certainly remain unused until some further scheme similar to the grid is commenced.

DISTRIBUTION

STANDARDIZATION

SO FAR only the wholesale side of the electric supply industry has been considered. It is now necessary to consider fully the distribution or retail side of the industry, and to do this it is necessary first to outline the existing position. There are at the present time about 650 separate distribution authorities. Of these about 380 are local authorities, and about 270 are companies. The areas of supply vary enormously, ranging from a few square miles to several thousand square miles. The voltages at which domestic consumers are supplied are numerous, and very little progress has yet been made towards general standardization at 230 volts, which is the agreed standard voltage. Many undertakings continue to give direct current supplies, to the disadvantage of their consumers—both from the point of view of convenience and cost. In a survey which the Electricity Commissioners took in 1929 (at the

request of the Council of the Institute of Electrical Engineers) it was shown that electric lighting supplies in 1927-28 were allocated between voltages approximately as follows :

230 volts (standard)	22 per cent
220-240 volts (excluding 230 volts)	32 per cent
200-215 volts	38 per cent
Above 240 volts	4 per cent
Below 200 volts	4 per cent

The above figures do not take into account the difference between alternating current and direct current. Some of the lighting load at the standard voltage is direct current. There was therefore less than 20 per cent of the total domestic load standardized at 230 volts alternating current. The remaining load, partly alternating current and partly direct current, was supplied at a multiplicity of voltages.

This lack of standardization involves immense inconvenience to the public, and very great cost. For instance, any person who moves from one district to another, or in some cases from one side of a street to another, may be involved in replacing or altering any electrical appliances he may possess, and the costs of

small industrial motors and other apparatus are increased by the impossibility of bulk manufacture for one voltage. The cost of distribution is also increased for systems (the majority) operating below 230 volts, and more especially for systems employing direct rather than alternating current.

Since the above figures were compiled there has probably been comparatively little change, although it would be desirable to make immediately a fresh survey in order to bring the figures up to date. The Electricity Commissioners have tried to encourage the standard 230 volt alternating current system for extensions undertaken recently, and all new distribution systems have been laid down at the standard voltage. Unfortunately this is not enough, because the non-standard systems continue themselves to expand and grow, and the proportion of standard to non-standard may remain little changed, despite the fact that all new systems are standard. The position in 1929 is illustrated by the following extract from a letter written by the secretary of the Electrical Contractors' Association to the Electricity Commissioners :

My Council, at its last meeting, considered reports from various centres as to the comparatively large extensions which were being carried out at the present time differing from the standard voltage of 230-400 volts. . . .

My Council does not think for one moment that the Electricity Commissioners are not doing their best to deal with the situation, but my object in communicating with you is to ask that every possible effort should be taken to ensure standardization, as extension at non-standard voltage seriously affects the selling costs, due to the large stocks of lamps and domestic appliances which it is necessary to manufacture and stock, and to the fact—and we regard this as a very important one—that it deters consumers who contemplate changing their residence, from purchasing electrical equipment which they would otherwise do at the present time. . . .

My Council would also be pleased to learn what steps, if any, the Commissioners have in view for the standardization of existing voltages of supply, particularly in adjoining areas, where the difference in some cases is only 10 or possibly 20 volts. . . .

It may be wondered why the Electricity Commissioners had not previously taken more definite steps with regard to standardization. The answer is that the Commissioners had neither the power nor, owing to their largely judicial function, the inclination to take positive action. Such action as is within the scope of their powers has indeed been taken since

1929 as the result of the considerable public feeling which has become manifest, but the results have, as already stated, been relatively slight. Obviously the position could only be cleared up by a bold decision to standardize, such as was taken in the wholesale field with regard to frequency. The cost of voltage standardization (not including change from D.C. to A.C.) was estimated in 1929 to lie between £10,000,000 and £16,000,000. The cost to-day would probably be substantially greater, but, relative to the total capital involved, the cost of voltage standardization is comparable with that of frequency standardization already completed or nearly completed.

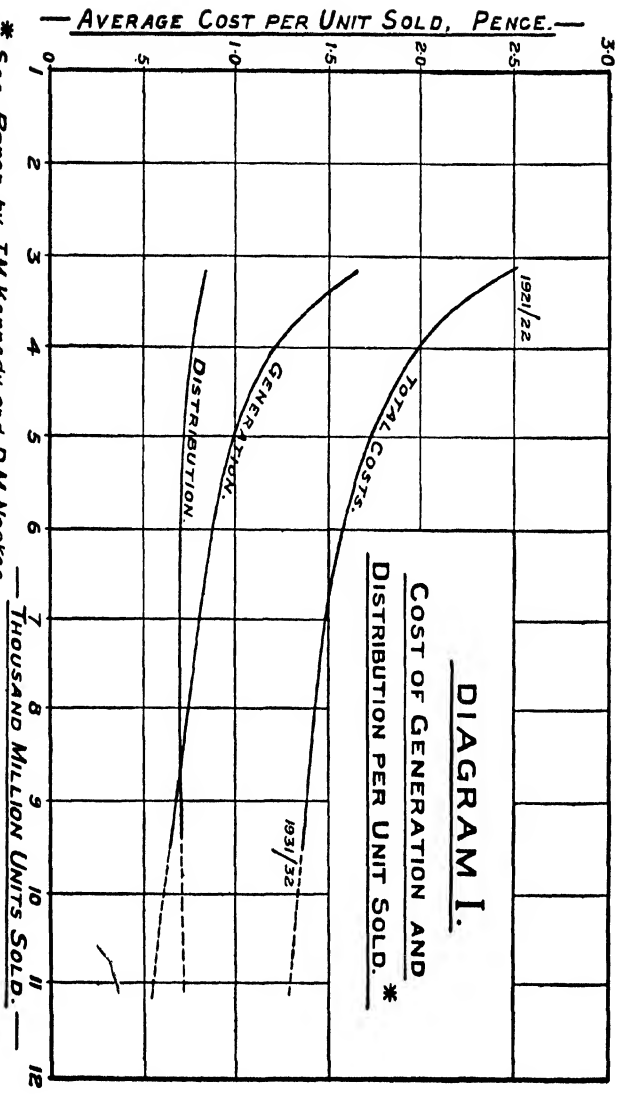
While it is obvious that standardization can only be effected by a bold move such as that successfully accomplished in the field of wholesale supply, it is equally obvious that the hope of such a bold policy being carried through is very small—in fact negligible—so long as the retail side of electric supply remains in the hands of between six and seven hundred authorities and companies. For this reason alone it is imperative that distribution be placed in the hands of

a few large regional authorities, themselves under one central authority capable of tackling this vital problem of standardization.

DISTRIBUTION AREAS

Apart from the problem of standardization, it is, of course, quite ludicrous that there should be six or seven hundred authorities with as many different types of tariff, confusing to the public and resulting in gross inequality of price. The absurdity of the present situation is illustrated by the map opposite, showing the number of authorities in London and the area south of the Thames. As will be seen, there is a host of company areas, interspersed in which are the local authority areas. There is obviously no attempt at logical planning of the boundaries of areas or their sizes, and some of the areas are manifestly far too small. The curves in Diagram 1 show how little change there has been in distribution costs in the last twelve years, although in generation there has been a substantial fall.

It has been argued in defence of private enterprise in the field of distribution that the size of area is not directly related to the total



* See Paper by J.M. Kennedy and D.M. Nookes read before I.E.E. 1933.

cost of distribution, or that the capital cost of a distribution system does not decrease with increase in the area covered. While it may be agreed that as regards capital cost very large-scale operation has somewhat less effect in distribution than in generation and transmission, there can be no doubt that very great economies can be made, particularly in management and operating costs, by large-scale operation. There can also be little doubt that substantial savings would in fact be made in capital costs. In a paper read before the Institution of Electrical Engineers in February 1933 by Mr. J. M. Kennedy and Miss Noakes—the first paper to criticize broadly the whole existing organization of distribution, and one which raised a storm of criticism—it is shown, from statistics compiled by the Electricity Commissioners, that, if the total revenue of each undertaking be allocated as between generation and distribution, the latter portion, expressed as a percentage return on the distribution capital of each undertaking, ~~varies~~ varies inversely with the amount of this capital. Thus the average percentage return for a small undertaking with less than £250,000 capital

investment in distribution (nevertheless large compared with some of the existing undertakings) is over 25 per cent, while for a capital investment of between £1,000,000 and £2,000,000 this figure is reduced to about 15 per cent. The present average capital investment in distribution for the 650 undertakings is £300,000, the great bulk of undertakings being below this figure. While the above figures cannot be accepted as conclusive evidence of the economy of large distribution areas, they are fairly convincing. Perhaps the most convincing proof lies, however, in the fact that some of the most successful distributing authorities cover areas up to 5,000 square miles, or populations up to nearly two million, and capital expenditure on distribution up to £7,000,000, and that there is invariably a tendency for the larger authorities to expand and to absorb, so far as may be possible, adjoining areas.

The argument for large areas is not wholly based on economies thus made possible, but depends also on the advantage to consumers of dealing with one authority covering a wide area, and of having uniformity of tariff and

good salesmanship. Probably the fact is that very appreciable economies are to be made as average mixed urban and rural areas are increased in size up to at least 1,000 or possibly 2,000 square miles—representing capital investment in distribution of several million pounds. Thereafter the economies are likely to be less as the areas increase in size, but, because of the other advantages of uniformity and standardization mentioned above, it may be desirable to have areas considerably greater even than 2,000 square miles.

In the paper by Kennedy and Noakes referred to above, it is shown that very little improvement has been effected in recent years in the units sold per £ of distribution capital. The figure for 1931 is in fact lower than in any year since 1921, and it is primarily the number of units sold per £ of distribution capital which settles the cost per unit of distribution. Many of the companies, particularly the smaller ones, had adopted a retrograde policy of “large profits, small turnover,” the effect of which was to keep sales low and distribution cost high. The vicious circle so established can only be broken by a bold reduction of

prices, which, as is shown in the paper referred to above, may very well result in increase in net revenue and the possibility of a further reduction in prices. The present position is that few companies and not all municipal undertakings are prepared to adopt this bold policy. Consequently the public suffer.

DISTRIBUTION IN RURAL AREAS

This is still more true as regards the development of rural areas. To give the benefit of electric supply to such areas—and it is a very great benefit indeed—a bold progressive policy is absolutely essential. The distribution system must be laid down first, and then the load built up by the adoption of a low tariff. Such a policy—which means losses in the early years of development, followed by small profits on a large turnover in the later years—is the very antithesis of the policy of many companies. The following is an extract from the Electricity Commissioners' Annual Report for 1931 :

The salient feature revealed by the foregoing statistics is the predominating influence of the " large consumers " upon the developments which have hitherto taken place in the rural areas of supply. The figures point definitely

to the conclusion that much of the development has been on the basis of specific and possibly sporadic extensions of systems for the express purpose of securing individual factory and power loads of sufficient value in themselves to justify the initial outlay involved.

There has undoubtedly been a tendency in many rural areas for such loads to be regarded as the primary objective of development, and for the smaller individual demands of the rural population, of farms, etc., to be regarded as useful supplementary loads to be secured as and when they represent remunerative additions to the supply systems. Such a tendency was perhaps to have been expected in embarking on a new phase of electrical development in this country.

It is becoming increasingly apparent, however, that, to secure the greatest possible measure of rural electrification and the fullest use of the capital expenditure involved, development must be proceeded with on the basis of carefully planned schemes of transmission and distribution for a rural area of supply as a whole ; and that due regard must be had to the potentialities, not only of the larger individual loads, but also of all the communities, farms, etc., capable of being served.

The degree of development attained will be influenced to an important extent by the existence or absence of other factors, such as the offer of an attractive two-part tariff designed to encourage the fullest use of electricity ; the offer of facilities in the way of schemes of assisted wiring, and of hire and hire-purchase of apparatus, whereby initial installations or extensions can be provided without necessitating large cash payments by potential or existing consumers ; the provision of an efficient maintenance service ; and active propaganda and demonstration.

Full use has not hitherto been made of the foregoing factors by all of the undertakings engaged in rural developments. Even in the areas where supplies have been established, there is still much scope for obtaining new consumers and also for bringing about the more general use of electricity for a variety of purposes by the consumers already connected to the supply systems, as shown by the preceding statistics.

The Electricity Commissioners are not a body who would make such charges unless there was good reason for doing so.

It should also be mentioned that two members of the Commissioners' staff—Messrs. Dickinson and Grimmett—read in 1931 a paper on rural distribution before the Institution of Electrical Engineers. This paper analysed in detail the cost of rural distribution and the prospects of consumption. The conclusions reached are that the costs of distribution in rural areas are not so very different from those in urban areas, because of economies due to the use of overhead construction, and that consequently the electrification of sparsely populated areas is a practical proposition provided it is recognized that losses must be incurred during the first few years—up to, say, five years or so in very sparsely populated

areas. Messrs. Dickinson and Grimmett's paper may be somewhat optimistic in certain respects and open to criticism in detail, but, broadly, the authors establish their case. The development period during which losses will be incurred in a rural area may be somewhat longer than they estimate, or—more probably—the rapid success of rural schemes could only be assured if carried out on a bigger scale than they assume, but, in either event, it is of little use to look to private enterprise, or to municipal enterprise, to electrify the rural districts of the country in the near future. Some more or less experimental work has been done on intensive rural electrification, but it is exceptional, and some of the more outstanding work of this sort has been done by local authorities—as, for instance, the Bedford, Norwich, and Chester corporations' rural electrification schemes; the two former corporations receiving financial assistance from outside sources. These schemes are on a small scale, covering areas varying between about 100 and 140 square miles. As has been indicated earlier, such areas are much too small, although it has to be borne in mind that in the above instances they are associated

with the urban areas of supply of the three corporations in question, and therefore, to some extent, form part of larger areas. Experience up to date on the three areas shows that the Chester scheme (started about ten years ago) has reached the remunerative stage, while the other two, after only three or four years, are still running at a loss, although with a very rapidly rising consumption of electricity which will in all probability result in their becoming self-supporting in another few years. It is unfortunate, and at the same time condemnatory of distribution in this country, that only a few small-scale experiments such as the above have been made on intensive rural distribution, bearing in mind that electric supply in Great Britain started some fifty or more years ago. Nor can criticism be confined only to lack of progress in rural areas. Even in urban areas, particularly those in the hands of companies, progress has been very slow. Some of the larger municipal areas, where a really progressive policy has been followed, show what can be done, but few municipalities supply large rural areas in conjunction with their urban areas, and therefore such undertakings

have not got the characteristics essential to proper development of distribution, namely, supply to large mixed urban and rural areas.

If a rapid development were to be carried out in all areas the present capital expenditure on distribution, large though it is (over £200,000,000), would have to be enormously increased. It is therefore vitally important that distribution be properly planned and co-ordinated in the future if a vast wastage of expenditure is to be avoided, and if, within reasonable time, all the people of this country are to obtain the benefit of electric supply. The following section of this book outlines a scheme designed to achieve these results.

FUTURE ORGANIZATION—GENERAL CONSIDERATIONS

In the preceding section reasons have been given for the reorganization of electric distribution on the basis of large regional areas. The control of these regional areas would be in the hands of regional boards whose function would be to carry out the retail business of electric supply on a self-supporting but non-profit-making basis. In order to achieve

co-ordination and standardization, and to ensure the adoption of a progressive policy, it is essential that these distribution boards should themselves be under the general control of a central national authority. In attempting to work out the details of such an organization it at once becomes apparent that the problem is related to the more general problem of the future organization and relationship of central and local government. Since the solution of this general problem lies in the future, it cannot be hoped at this stage to define an organization which will necessarily fit in exactly as a component part of the solution of the general problem. In any event, it cannot be expected that a definite and final solution of either particular or general problems of this type is possible. A process of intelligent experiment in organization will, it is to be hoped, be one of the main features of the future history of this country. Such experiment can only be really successful if it is a deliberate policy, and if all possible steps are taken, in the interest of the country as a whole, to prevent vested interests interfering with the logical solution of the problem. The following proposals with regard to the

future organization of electric supply do not necessarily assume any changes having been made in the present organization of central or local government, but they are such that modification to fit in with any such changes would probably be fairly easy.

The principal existing bodies concerned in electric supply are the Electricity Commissioners, the Central Electricity Board, local authority undertakings, and company undertakings. Mention should also be made of the three active joint electricity authorities—London, North-West Midlands, and West Midlands. Any reorganization of the industry should not only eliminate certain of these existing bodies but should avoid creating any more new bodies than absolutely necessary. Socialization of the industry will, of course, result in the disappearance of the companies, a total of about 270, but it might not necessarily involve the disappearance of the local authorities. If distribution is to be carried out on a large-scale regional basis in the future, it is, however, clear that neither municipal nor any other existing local authorities are suitable bodies to which

to entrust this function. Experience with the wholesale work of the Central Board has shown that, except possibly the very large undertakings, local authorities are not, in general, suitable authorities for carrying out generation and transmission, and, of course, the same is true of the companies. Purely from the point of view of efficiency, the main consideration applying both to the wholesale and retail business is to obtain an authority operating on a large scale, able to avoid a parochial point of view, and employing really first-rate and fully qualified staff. It is not, of course, suggested that exactly the same considerations apply both to generation and to transmission and distribution. Generation and transmission can most satisfactorily be dealt with almost wholly by a central authority for the whole country, i.e. the Central Electricity Board working through district offices under its immediate control. Distribution, on the other hand, must involve a much greater measure of local control, together with adequate central control, but the local control should, for reasons already given, be exercised over much wider areas than those in the hands

of most local authorities at the present time. Each regional area will include many cities, towns, villages, and purely rural areas, and consequently the creation of special regional authorities will be unavoidable.

As regards the existing central authorities, i.e. the Electricity Commissioners and the Central Electricity Board, it has already been pointed out that the functions of the former are largely judicial, while those of the latter are largely executive. It appears, therefore, that the Electricity Commission might in the reorganized industry be retained almost unchanged, except that their function would be made wholly judicial. They would, in fact, be a court of appeal, to which any bodies or private individuals whose interests were affected by the operations of the central or regional executive authorities could appeal. They would also have the function of ensuring that the central or regional executive authorities operated in accordance with the terms of the Acts of Parliament from which their powers were obtained. The Electricity Commissioners would therefore remain directly under, and responsible to, the Minister of Transport.

As the Central Electricity Board is at present the central executive authority for the wholesale business of generation and transmission, the question arises whether or not another central authority for the retail business of distribution is required. Apart from the general objection to creating another authority, it appears that, unless there is an absolutely clear distinction between the wholesale and retail business, little justification could be found for a new authority. The distinction that has been drawn, up to the present, between the wholesale and retail business appears, on examination, to be somewhat artificial. Transmission and distribution merge into each other without any real line of demarcation, and the distinction drawn previously has probably largely been the result of public control of the one, and private enterprise control of the other. In fact, to some extent, the supposed clear distinction between the wholesale and retail sides of the electric supply industry has been used largely as an excuse for permitting the one to be under public control, while not permitting private enterprise to be interfered with in the other.

Previous to the passing of the 1926 Act several of the larger companies controlled generation, transmission, and distribution within very large areas up to about 5,000 square miles, and showed that it is not, in fact, essential to have separate controlling authorities for the wholesale supply and the retail supply. It appears, therefore, that while distribution does call for a large measure of local control, there is not sufficient reason for the creation of a central controlling body other than the existing Central Electricity Board. The first task of the Central Electricity Board, the creation of the grid, is now virtually completed, and, with suitable modification to its composition, there appears to be no reason why it should not have its function extended to embrace the central national control of both the wholesale and retail sides of the industry. This, indeed, is in accordance with the opinion expressed by the original Williamson Committee for dealing with electric supply *ab initio*, as quoted earlier in this book. In accordance with the above considerations the reorganization of the industry would be as follows :

DETAILS OF FUTURE ORGANIZATION

The whole country would be divided into about ten regions, corresponding, approximately, to the nine areas of the grid scheme (one or two areas being subdivided or partially combined). Within each region, the ownership of all existing undertakings, both local authority and company, would be vested in the Central Electricity Board, who would delegate the administration and operation of the undertakings to regional boards under the general control of the Central Board. The exact number and boundaries of these regions would, of course, require to be the subject of a special investigation to be carried out by the Electricity Commissioners in consultation with the Central Electricity Board, but the completion of such an investigation need not delay the passing of the necessary legislation.

Each regional board would consist of a chairman and five members, of whom two would be appointed by the Ministry of Transport (which is the Government department at present responsible for electric supply) after consultation with the local government

authorities within the region. One other member would be appointed on the grounds of general qualifications, and the two remaining members after consultation with the workers' associations concerned. The chairman of each regional board would be appointed by the Minister of Transport on general grounds. The chairman and the member appointed on general grounds would be full-time members, the remaining four being part-time.

The existing Central Electricity Board, which would now have general control over the whole industry and therefore over the various regional boards, would, in future, consist of five members and a chairman. Of the five members, two would be appointed by the Minister of Transport on general grounds, one would be appointed after consultation with the workers' associations concerned, and two would be appointed after consultation with other industries and services affected, particularly the electrical manufacturing industries and the railways. The chairman would be a full-time appointment made by the Minister on general grounds. Of the members of the Central Electricity Board, the two appointed on general

grounds would also be full-time, the remaining three being part-time only. Associated with the Central Electricity Board would be a consultative council, consisting of the ten chairmen of the regional boards, and meeting at regular intervals.

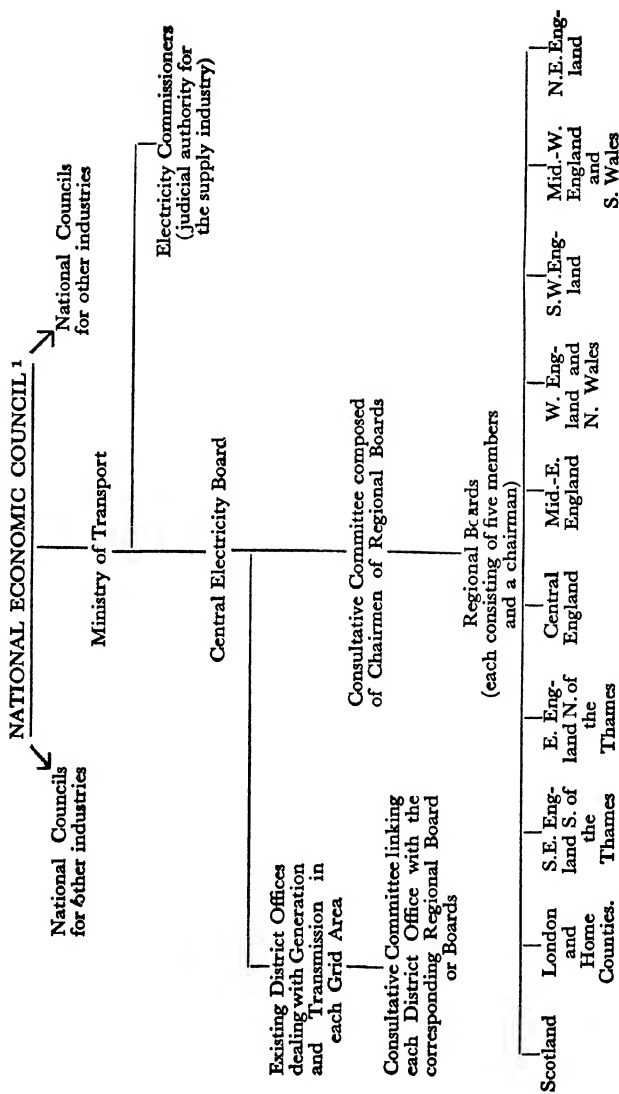
The representation of workers on the controlling bodies proposed above would, of course, be subject to such decisions on workers' representation as may be taken in the future.

The operations of the regional boards would be subject to the general control of the Central Electricity Board as regards the approval of schemes for co-ordinating and extending the distribution system within the area, and for effecting standardization, subject to a decision by the Electricity Commissioners in the event of any dispute. Capital required for distribution expenditure would be raised on the security of the whole electric supply industry by the Central Electricity Board, and would be allocated to the regional boards for the carrying out of approved schemes of distribution. The expenses of the Central Board on account of distribution would be covered by a levy on the unit output in the same manner as

the expenses of the Electricity Commission are met at the present time.

Operation of the selected power stations and of the grid would be carried on by the Central Electricity Board as at present, but the actual ownership of the power stations would be vested in the Board in order to avoid the present anomaly whereby the Board controls the operation of power stations owned by the existing municipal and company undertakings. It will also be desirable to transfer to the Board railway and certain other non-statutory generating stations which are at present excluded from the Board's control, and which should, from a national point of view, form part of the grid system. The above proposals are shown in diagrammatic form below.

The three joint electricity authorities in active existence at the present time would be merged in the corresponding regional boards, as in the case of local authority undertakings. These three joint electricity authorities, namely, London, North-West Midlands, and West Midlands, exercise comparatively limited functions, and the capital involved is relatively small.



¹ Assumed in existence, but not part of the organization described in this book.

LARGE MUNICIPAL UNDERTAKINGS

A few of the larger municipal undertakings such as Manchester, Liverpool, Birmingham, Edinburgh, Glasgow, etc., at present operate distribution systems sufficiently large (measured in capital expenditure or sale of electricity) to make possible most of the economies due to large-scale operation, and it is therefore possible to visualize a scheme in which these larger municipal undertakings are constituted special regional boards, possibly with their areas of supply extended. If distribution were to be regarded merely from the point of view of the present position, and without allowing for very great growth in the future, such an arrangement would doubtless be easier to effect, and would avoid the opposition of some of these municipal authorities to the more drastic scheme suggested above, involving transference of ownership. It would, however, be wrong to regard the problem from this point of view, because it is certain that enormous expansion of distribution will occur in the future, resulting in the present expenditure being correspondingly increased. The population of

these large cities may shift outwards, involving extensions of the city boundaries into areas at present rural and under other supply authorities. Consequently any separation of the large municipal undertakings from the regions in which they are situated is likely to involve difficulties in the future, and to restrict the application of comprehensive schemes. It might also add to the difficulty of effecting standardization of voltage and type of current. Apart from such difficulties, it is doubtful, from a general point of view, if municipal government is best suited to the operation of services such as electric supply where a very rapid growth is in progress, and where major technical changes must be anticipated in the future involving decision in policy of a regional, if not of a national, character. Such considerations raise the whole problem of the future relationship of central and local government, which urgently requires more detailed study. As has already been pointed out, it is impossible by a pure theoretical study to arrive at the best form of organization. The aim must be to start with an organization which is more or less on the right lines, but which will be subject to modification

as the result of practical experience. Now it is just from this point of view that it is undesirable to have within the supply industry two forms of ownership and control, i.e. regional (under central control) and municipal (with or without central control). Such an organization would be less flexible than one in which ownership and control are confined within the scope of a uniform plan for the whole country. Nevertheless the proposals outlined above could, if necessary, be modified so as to retain certain of the larger municipal undertakings as special regional boards, provided they were, as in the case of the other regional boards, under the general control of the central authority, and assuming their areas of supply to be considerably enlarged.

ORGANIZATION OF REGIONAL BOARDS

It must be appreciated in connection with the foregoing considerations that, whatever the exact form of the future organization of the supply industry, the existing organization and staffs of both the local authority and company undertakings would retain their present functions, and would, in fact, be the machinery

taken over by the new regional boards. Changes would, of course, be effected gradually as the result of experience, and no doubt it would be desirable by degrees to merge the executive machinery taken over from certain of the smaller undertakings in that taken over from the larger adjacent undertakings whose spheres of operation would be correspondingly increased. This machinery taken over by the regional boards, and modified as required, would provide the further subdivision and delegation of function necessary to meet the particular local or individual requirements throughout each region. In effect, therefore, each region would ultimately be subdivided into a number of districts, each under the immediate control of a district engineer, to whom the regional board should give considerable discretionary powers while retaining control of the general planning and development of the region as a whole.

CONSULTATIVE COMMITTEES

Although the proposed scheme provides for representation of local authorities on the regional boards, it will probably be desirable

to provide some machinery for further representation of local interests. This could probably be done satisfactorily by creating a consultative committee in each region. These consultative committees would consist of representatives appointed by local government authorities within the region, so chosen as to represent the interests of both the rural and urban areas within the region. Provision for some representation on each committee of other industries within the region, particularly gas, and including the workers in such industries, would also be included. The co-ordination between gas and electricity is discussed later. The function of the committee would be purely advisory, but meetings would be held at regular intervals, so that any suggestions or grievances could be given proper expression without unreasonable delay. The meetings of the consultative committees would be presided over by the chairman, or, in his absence, by a member of the regional board. In the event of the consultative committee feeling that its views were not being given proper attention by the regional board, the committee would, by a majority vote, have the right of referring the matter, in

the first instance, to the Central Electricity Board, and from them to the Minister of Transport. The latter would, if he thought fit, order an enquiry by the Electricity Commissioners, the judicial authority for the whole supply industry.

It is interesting to note that consultative committees having a similar advisory function, but, of course, representing the existing undertakings, as provided for in the 1926 Act, have been created by the Central Electricity Board in connection with each of their present area schemes of wholesale supply, and these committees appear to serve a useful function. Such existing consultative committees would be retained to form the link between the regional boards, which replace the existing undertakings, and the "grid" district offices, which are the Central Electricity Board's local offices for the control and operation of the grid, and which would not be altered by the foregoing proposals.

TRANSFERENCE OF OWNERSHIP

The main feature of the above proposals is the transference of the ownership of local authority and company undertakings to the reconstituted Central Electricity Board. It is

necessary to consider, therefore, the basis on which this transference is to be effected. The total of outstanding loans for local authority undertakings was, at the beginning of 1932, approximately £130,000,000, and the total of share, debenture, and loan capital in the company undertakings was approximately £125,000,000. The latter figure is made up as follows :

Ordinary . . .	£60,000,000
Preference . . .	£20,000,000
Loans and Debentures	£45,000,000
Total ¹ . . .	<u>£125,000,000</u>

The total of reserves held by the company undertakings was £27,000,000.

The total capital expenditure on electric supply up to the beginning of 1932 was as follows :

Local authorities . .	£232,000,000
Companies . .	£149,000,000
Total . . .	<u>£381,000,000</u>

¹ Not including some £5,000,000 for combined electricity, gas and other undertakings, for which particulars are not available. The capital expenditure of these undertakings, is however, included in the figures given below.

Of these amounts the following sums were provided out of revenue :

Local authorities . . .	£18,000,000
Companies . . .	£20,000,000
Total . . .	<u>£38,000,000</u>

The average market value of the company stock was considerably greater than the nominal value, and the total market value was probably of the order of £200,000,000. The simplest method of purchase of the existing undertakings would be, in the case of local authorities, by the Central Electricity Board accepting responsibility for all outstanding loan charges, and, in the case of companies, by the issue of fixed interest-bearing, but redeemable, bonds. No variable interest bonds would be issued. The question arises whether such bonds should be issued by the Central Electricity Board or by each regional board. There appear to be strong arguments for making the security of the new bonds as great as possible, and obviously this will be best effected if they are issued by the Central Electricity Board and represent the security of the supply industry

for the whole country rather than the security of the industry in each separate region. The latter security would necessarily differ slightly for different regions ; for instance, the southern regions, towards which industry is tending to migrate, might be considered to offer greater security than the northern regions. Moreover, at the time when the legislation effecting this reorganization of the supply industry is passed, there will be no regional boards in existence, but the Central Electricity Board, even though the scope of its functions is to be greatly enlarged, will be in existence, and will probably, as an existing body, be regarded with somewhat greater confidence than bodies yet to be formed and proved. Taking these matters into consideration, it appears desirable that the new bonds should be issued by the Central Electricity Board and secured on the revenue from the whole supply industry of the country.¹ Each regional board would, however, be required to make as a first charge on its revenue the interest in respect of that amount of outstanding local authority loans, and of bonds representing

¹ It is possible, of course, that it might be decided to issue national bonds for all socialized industries, i.e. bonds guaranteed by the State and not dependent on each industry.

the purchase price of the undertakings in its region. In the event of failure of any regional board to meet these charges, the Central Electricity Board would have power, with the approval of the Electricity Commissioners after an enquiry into the circumstances, to levy a *pro rata* contribution on other regions to meet the outstanding interest. The amount so contributed would be repaid by the regional board in question out of future revenue, unless in the opinion of the Electricity Commissioners the circumstances were exceptional and justified the subsidizing of one region by the others.

The various regional boards would be required, not only to meet interest charges on the loans and bonds, but also to create a sinking fund to write them off, this being the equivalent of the present depreciation and loan repayment rates fixed by the Electricity Commissioners for municipal undertakings.

In the case of local authority undertakings the Central Board would accept responsibility for all outstanding loan charges, or any capital provided out of revenue or from the general rates, and not repaid, and therefore no special problem arises in respect of the £130,000,000

so involved. The position is, however, very different as regards the company undertakings, the market value of whose shares depends at present on the Stock Exchange's or general public's estimate of future prospects. This market value does not necessarily represent the actual value to the public of the assets of the company. For instance, the shares of a small company may stand higher than their yield apparently justifies, because of speculation in the prospect of the company being bought up at a high price by some larger undertaking or holding company. An example of this was to be seen a few years ago when American interests bought up, at very enhanced prices, the shares in a number of company undertakings in various parts of the country. Then, again, a company working on the "small turnover, large profit" basis may have spent a comparatively small sum in developing only the "plums" in its area, and may on this small expenditure be paying high dividends, the market value of its shares being correspondingly high. Alternatively the capital may have been watered by the issue of bonus shares, so that the total of share capital at

market price may considerably exceed any reasonable valuation of the actual physical assets of the undertaking. Many other similar or more complicated circumstances may exist, making it very difficult to settle on a reasonable purchase price from the point of view of the public.

This problem will, of course, arise in all industries during the process of socialization, and as yet no definite principle has been laid down for dealing with the difficulty. Expropriation without reasonable compensation is not considered here, because it appears that the more equal distribution of wealth required in a Socialist community should be achieved by direct measures rather than by indirect measures which might be inequitable in their results. Subject to some general principle of compensation applicable to all socialized industries being laid down, it is proposed, for the purpose of the present book, that compensation should be based on the average market value of the shares over the period of the three years prior to the passing of the necessary legislation, provided this value bears a reasonable relation to the actual value of the assets

of the undertaking, including the reserves held by the companies, which at the beginning of 1932 amounted to £27,000,000. In cases where the share value obviously greatly exceeds the actual value of the assets, a special valuation on the basis of cost price less depreciation would be made for the purpose of ascertaining a reasonable compensation value. The bonds in which compensation would be paid would carry interest at a rate not exceeding one quarter per cent in excess of the current yield of corresponding Government securities. While such proposals are not wholly satisfactory, and do not necessarily penalize the undertakings who have in the past been exploiting the public, it is unfortunately impossible to do so equitably, since those owning shares in such companies are not necessarily those responsible for exploitation. Also it would be difficult or impossible to ascertain real relative degrees of exploitation of different company undertakings. Incidentally a few municipal authorities, who in the past have largely subsidized rates out of profits on electricity undertakings, could also be charged with exploitation.

Shares in supply companies are at present

considered a very safe investment, and consequently the market price is high and the yield correspondingly low. Assuming the present average yield on all capital to be about 4 per cent, the replacement of this capital by redeemable bonds of corresponding capital value secured on the whole industry, and bearing interest at, say, $3\frac{1}{2}$ per cent, would result in capital charges being reduced, in the case of undertakings previously belonging to companies by about 12 per cent.

BODIES ASSOCIATED WITH THE ELECTRIC SUPPLY INDUSTRY

Apart from the principal authorities already mentioned, there are a number of other bodies associated with the industry, a classified list of the more important of whom is given below.

Under the column headed "Workers" in the table below, there is first the National Joint Industrial Council on which are represented the unions for all workers below the grade of charge engineer (the E.T.U., the A.E.U., and the general workers' unions) and the employers. Then there is the National Joint Board on

BODIES ASSOCIATED WITH THE ELECTRIC SUPPLY INDUSTRY

<i>Workers</i>	<i>Publicity, Commercial, etc.</i>	<i>Technical</i>
National Joint Industrial Council for the Electric Supply Industry.	British Electrical Development Association.	Institution of Electrical Engineers.
Electrical Trades Union.	Electrical Association for Women.	British Electrical and Allied Industries Research Association.
Amalgamated Engineering Union.	Incorporated Municipal Electrical Association.	British Standards Institution.
National Union of General and Municipal Workers.	Incorporated Association of Electric Power Companies.	Institute of Fuel.
Transport and General Workers' Federation.	Electrical Contractors' Association.	
National Joint Board of Employers and Members of Staff for Electric Supply Industry.		
Electrical Power Engineers' Association.		
Associated Municipal Electrical Engineers.		

which are represented the E.P.E.A.¹ and the employers, the former being the union for workers graded as charge engineers and above. The distinction drawn between the grades appears somewhat artificial, and it is to be hoped that ultimately all workers of all grades might be represented on the National Joint Industrial Council, including representatives of the national and regional boards, while representation of the present employers would, of course, cease.

Of the commercial and other associations, those concerned definitely with either municipal or company undertakings would disappear as such. The Electrical Development Association (E.D.A.) is an important body carrying out general publicity for the whole supply industry, but is not a profit-earning concern in itself. It is already largely under the control of the Central Electricity Board, and might be taken over as part of the Central Electricity Board's enlarged organization. It might also be desirable to have some special representation on the managing committee from the various regional boards.

¹ Electrical Power Engineers' Association.

Of the technical bodies wholly concerned with the electrical industry, the two most important are the Institution of Electrical Engineers and the British Electrical and Allied Industries Research Association. The British Standards Institution is also important, but is concerned with all industry, and not only with the electrical industries.

FUTURE USE OF ELECTRICITY

GAS AND ELECTRICITY

THERE IS at the present time considerable and growing competition between gas and electricity. This competition has probably only become really serious in the last ten years or so, but now electricity is competing vigorously with gas for the domestic cooking and heating load which previously had been almost entirely supplied by gas. As regards the industrial power load, there can hardly be said to be competition, since this, for some time past, has been almost wholly supplied by electricity. Domestic lighting has also been largely captured by electricity, though the great bulk of the heating and cooking load, together with a large amount of street lighting, is still supplied by gas. In the last few years a great deal of publicity has been given to electricity, and with the reorganization of the central publicity body, E.D.A. (the Electrical Development Association), which is largely financed by the Central Electricity Board, the industry is now

embarking on a more intensive policy of publicity and improved salesmanship. The gas industry has responded by vigorous advertising, and on both sides there is a considerable amount of feeling, which is reflected in the technical Press and elsewhere. On the one hand, electrical engineers point to the rapidly growing consumption of electricity and the diminishing consumption of gas, and express confidence that gas will soon be driven out of business altogether, while, on the other hand, gas engineers point to the unfair advantages electricity supply has been given by the publicity and attention bestowed on it by Parliament, by the hampering legislation from which the gas industry suffers, and by the fact that electricity can offer differential tariffs which are not permitted to gas.

While a certain degree of competition may be held to be beneficial and healthy, there can be no doubt that if allowed to grow unchecked, and in the absence of any attempt to co-ordinate the two services, much wasteful expenditure will result on both sides, from which the community as a whole will suffer.

There is little possibility at present of the

relative merits of gas and electricity being considered impartially, or their activities being so organized as to avoid waste and give the public the best combined service. Nor is consumers' preference an altogether reliable guide as to the relative advantages of the two services, since such preference may, to a considerable extent, be affected by the relative efficiencies of advertising rather than of the services themselves.

The socialization of the gas industry would probably permit appreciable economies in gas costs to be effected by means of regional gas-grids using high-pressure mains, by amalgamation of the existing gas undertakings under regional boards and a central board, and by other means. Although economies so effected are not likely to be equal to those which have been effected by the electricity grid, or could be effected by complete socialization of electric supply, as proposed in this book, they are likely to be substantial. Moreover, the cost of gas may be greatly affected by the revenue obtainable in the future from by-products, this revenue being at present a very important item in the net cost of gas. (Such

by-products may also be obtainable in the future from plant operated in conjunction with electricity.) It is difficult, therefore, to make any proper estimate of the relative prices of gas and electricity in the future, although the cost of electricity will probably be reduced more rapidly than that of gas. It should be possible to reduce the price of electricity, assuming a two-part tariff consisting of a fixed charge and a charge per unit, at least to a $\frac{1}{2}d.$ per unit within a comparatively short time. Very low prices per unit are made possible by means of the two-part tariff, and, obviously, if a proper comparison of the costs of gas and electricity is to be made, the gas industry also must be free to adopt a similar tariff.

At a unit price of a $\frac{1}{2}d.$, or less, the competition between gas and electricity, particularly for the heating and cooking loads, would be intensified, and, with free competition, a great deal more load might be transferred from gas to electricity. It is possible that this transference of load might happen to such an extent as to alter the whole relative position of industrial and domestic electric consumption, the latter predominating and giving rise

to new peak-load conditions. Such a position has, indeed, arisen, or almost arisen, in the case of certain local authority undertakings where extensive cooking loads are now supplied at about $\frac{1}{4}d.$ a unit. The result might, under certain circumstances, be uneconomic from a national point of view, because further expenditure would be incurred in the electric industry, and proper use might not be made of the capital already invested in the gas industry in the form of gas-mains and other plant. There is, at present, quite insufficient agreement as to the relative merits of gas and electricity, and far too much uncertainty about the technical improvements likely to be made in the future, to settle definitely how the two services are to operate jointly. Assuming both socialized, and both under the control of central boards, it is, however, possible to suggest a mechanism whereby these problems can be efficiently dealt with in the future, and to suggest certain general guiding principles.

In the first place, an effective interlocking of the two central authorities is necessary through a strong joint committee, meeting

at regular intervals to settle matters affecting both services. In the second place, the two boards would carry out, jointly, technical research, with the object of ascertaining the relative merits of gas and electricity for all the various purposes for which either is available. On the basis of such agreed data, decisions would then be taken as to how to avoid wasteful overlapping, and to provide the best possible service to the public. Such decisions would be communicated to the respective regional boards, where further consultation would take place through the consultative committees described earlier, in order to give effect to the decisions.

Such co-operation would undoubtedly give rise to difficulties, but, to some extent, these are unavoidable, and, of course, in the event of any deadlock, the matter would have to be referred for settlement to a higher authority—the National Economic Council—or, alternatively, a joint judicial authority for both services, which it might be desirable to form in the future. It appears, however, that there are certain broad principles which might be agreed between the two central boards. For

instance, it might be agreed that, for the time being, competition by electricity should be restricted in areas where existing gas-mains and other plant were not being fully used, and where further load taken on by electricity would result in expenditure not otherwise necessary on electric mains, provided that, at the same time, proper research was being made into the relative merits of the services, and decisions regarding future development being taken. Such a policy might result in the two services jointly advising the public in any given area to use gas for certain purposes and electricity for others, though such advice would necessarily be subject to alterations as circumstances changed.

It might also be accepted for the time being that in most urban areas both services should continue to be available to the public, this provisional decision also being subject to modification as prices changed and technical developments occurred. On the other hand, in all rural areas, except possibly a few which could be supplied with gas exceptionally cheaply from the regional gas-grids or by other means, the whole domestic load might

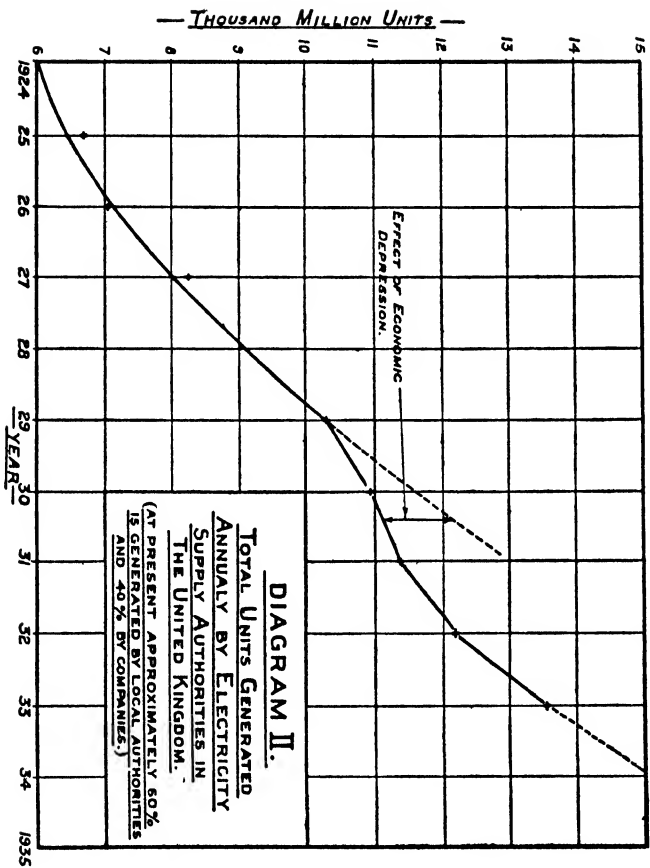
be allocated to electricity, so avoiding unnecessary expenditure on gas-mains. The reverse arrangement is not very feasible, because, even when a cheap supply of gas is available, there is a demand for electricity for lighting, wireless, domestic labour-saving appliances, and other purposes, which demand cannot be satisfied by gas.

In such ways at least some measure of co-ordination could be obtained, but much the most important matter is to provide for continuous impartial research into the relative merits of the services. Such research would involve some very difficult economic problems, and, of course, comparison of cost would require to be based, not merely on selling prices, which might to some extent be artificial, but on actual costs. The difficulty involved in such comparisons arises largely from the different characteristics of the two commodities, gas and electricity. The former can be stored, while the latter cannot. Consequently the electrical industry has always "surplus" units to dispose of, which can be sold very cheaply. Possibly no exact comparison of cost is possible, and, in any event, relative

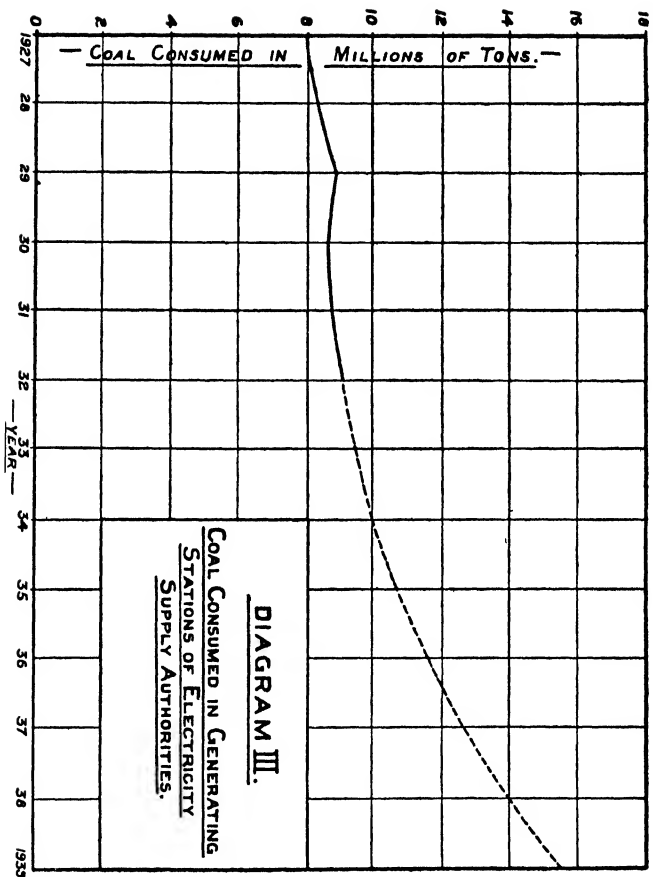
convenience is another factor which would tend to vitiate any such comparison, but, at least, research such as suggested would obviate the more serious wastage arising from unrestricted competition.

GROWTH OF ELECTRIC CONSUMPTION

In the course of the present book, emphasis has been placed on the rapid growth of the electric supply industry in the past, and the still more rapid growth which must be expected in the future. The curve shown opposite indicates the rate of growth in past years, but this curve should trend upwards at an ever-increasing rate, especially if the industry be reorganized on a Socialist basis, as proposed. The field for further electrical consumption is very large. Not only is there very great scope for further domestic consumption both in urban and rural areas, but in industry, quite apart from further mechanisation involving the use of electricity, there is still a very large horse-power of steam or other prime movers, much of which might, with profit, be converted to electric power. The total installed capacity of steam and other prime movers



amounts to about six and a half million horsepower, and, in addition, there is about 2·8 million kilowatts of privately owned electrical generating plant, much of which should ultimately be replaced by public supplies. Pending the complete socialization of all industry, it is desirable that the Electricity Commissioners should have power to prohibit the installation of further private electrical generating plant where they are satisfied supplies can be given more economically from the public system. The Commissioners have such powers at present as regards the installation of generating plant by authorised electrical undertakings, and the proposal is that this power should be extended to include private persons and companies of all sorts. Looking further to the future, there may ultimately be a large demand for electric power for agricultural purposes, though at the present time there are still technical difficulties in the way of any general adoption of electrical ploughing. A large demand is, however, possible in the near future for all kinds of rural purposes—particularly small rural industries, pumping, and threshing, etc.



The present average consumption is probably a little under 400 units per head, if allowance be made for the whole amount of electricity privately generated, and it is probable that this figure could be increased to at least 1,000 units per head in the next ten years. If developments on this scale are to take place, it becomes of great importance from the point of view of economy in capital expenditure and efficiency in operation, and even more so from the point of view of benefiting equitably all types of consumers, that the industry should not be allowed to grow in a haphazard fashion as in the past.

COAL CONSUMPTION

The curve on p. 95 (Diagram III) shows the coal consumed in generating stations belonging to authorized undertakings during recent years. Although, as shown in Diagram II, there has been a considerable increase in units generated during recent years, the consumption of coal has been affected by the simultaneous improvement in the thermal efficiency made possible by technical improvements, and by the concentration of generation in the larger and more

modern stations. Between 1927 and 1931 the consumption of coal per unit generated decreased by about 17·5 per cent. Further improvement will be effected in the future, partly because of further technical development, and partly because of the grid, but the rate must eventually diminish because of the decreasing margin within which improvement of thermal efficiency, which has thermodynamic limitations, is possible. Allowing, however, for a substantial improvement of thermal efficiency in the future, the dotted portion of the curve shows the probable increase in coal consumed in generating stations, assuming that, as indicated by the curve in Diagram II, the number of units generated in 1939, i.e. five years hence, will be at least 25,000 million units. This figure, of course, assumes that there is no deepening of the economic depression, but if, on the contrary, there should be a satisfactory reorganization of the supply industry and some improvement in industrial activity, or if railway electrification had commenced, the consumption by 1939 may be considerably higher. The probable increase of coal consumption of six

million tons in the next five years will, of course, be offset to some extent by a reduction in the amount burnt in open fires.¹

RAILWAY ELECTRIFICATION

There is one other possible field for electrical consumption to which special consideration must be given, namely, railway electrification. In 1929 a committee, presided over by Lord Weir, was appointed by the Labour Government to report on the electrification of the railway systems in Great Britain, with particular reference to main-line working, and in view of the greater availability of electric supply as a result of the creation of the grid. This committee reported, in 1931, in favour of general electrification, but pointed out that a decision depended ultimately on national, financial, and political considerations outside the scope of the report. The figures given in the report showed an estimated return of 6·7 per cent on a total capital investment of £261,000,000, but these figures were based on

¹ The consumption of coal is not likely to be appreciably affected by the development of water-power in Scotland or elsewhere because the water-power resources of this country, though not yet fully developed, are comparatively limited.

two very important assumptions—first, that *all* railways in Great Britain would be electrified, and, second, that the traffic density would be that corresponding to the traffic in 1929.

The figure of 6·7 per cent return on the capital expenditure has, since the publication of the report, been subject to much criticism, and it has been felt that the estimated return is too small to justify such an enormous capital expenditure, particularly in view of the uncertainties of the estimate. In general, there has been a tendency for the criticism to concentrate purely on the economic aspect of railway electrification, and to some extent to lose sight of a more important aspect of the problem which is summed up in the report in the following paragraph :

Electrification . . . places in the hands of a traffic manager a new machine or system which enables him to offer a more attractive transport proposition to his public, and whose special characteristics are capable of extensive development.

It is these characteristics of electrification which, wherever railway electrification has been carried out in other countries, appear to have accounted mainly for the success of such schemes.

The Weir report deals at length with the various advantages of railway electrification, and there is no object in attempting to cover the same ground in the present study. It is, however, worth while drawing attention to certain matters which must affect any final decision. In the first place, as mentioned above, the estimates assume the 1929 traffic figures, and the whole economic justification for electrification necessarily depends, to a very large extent, on what will be the future traffic on the British railways. Under existing conditions an estimate of the future traffic must necessarily be a pure speculation, but, if transport is socialized, it may very well be that a decision can definitely be made as to the volume of traffic which the railways will have to handle. If such a decision results, as it well may, in requiring the railways to legislate for a volume of traffic in excess of the 1929 figures—for instance, as the result of a national housing policy—the economic arguments in favour of railway electrification will be very greatly strengthened.

In the second place, the Weir report estimates assume complete electrification of all

railways in Great Britain. The total capital expenditure will be greatly reduced, and the return on capital increased, if only main lines, or lines carrying comparatively dense traffic, are electrified, the remainder being left under steam operation, or, alternatively, Diesel electric. There are also other factors, arising out of the change in circumstances since 1931, which would affect the report. The average return on capital has fallen so as to make a figure of 6·7 per cent return somewhat more adequate than before. Some economy would also be effected as a result of the substantial fall in the price of copper. On the other hand, the volume of traffic had decreased, at least until comparatively recently. This, however, is of less consequence if the traffic on the railways is to be definitely settled for the future, as suggested above.

There is one other factor which has tended to increase the hesitation in deciding on an extensive scheme of electrification. This is the suggestion that Diesel electric traction might be cheaper than pure electric traction. Strictly speaking the use of Diesel electric locomotives has little to do with electrification, because in

such locomotives the electrical part is largely a matter of gearing between the oil-driven prime mover and the wheels. There is no reason why the railway companies should not commence now to use Diesel electric locomotives, in place of steam locomotives, if they are satisfied that an economy can be effected thereby. The fact that they have not as yet adopted Diesel electric locomotives indicates that there is at least some doubt on this point, and, even allowing for the conservative attitude of the railway authorities, it would seem improbable that the large savings claimed by the manufacturers of Diesel engines would, in fact, be realized. Diesel electric locomotives have been used to a comparatively small extent abroad—for instance, in the Argentine on the Great Southern Railway. There is no doubt that they can be technically satisfactory, but the economy to be effected depends to a large extent on the price of oil in comparison to the price of coal. It is probable, in view of the extensive publicity given to Diesel electric locomotives recently, that the railway companies will make experiments in their use, and it is not improbable that such locomotives

may in the future displace steam locomotives for branch-line work. It is, however, very necessary to emphasize the fact that railway electrification and the use of Diesel electric locomotives are two quite different matters ; the latter is not directly comparable with electrification, and would have different characteristics.

It may also be mentioned that there has as yet been no development of storage batteries which is likely to have much effect on main-line electrification, despite sensational claims put forward from time to time. The Drumm battery, though still in the experimental stage, does, however, represent a distinct advance in battery design, and it may eventually prove suitable for use on branch lines where traffic density is low.

Some criticism has been levelled against the Weir report on the grounds that it is less concerned with the economics of railway electrification than with an attempt to justify the further loading and use of the grid. While there can be no doubt that the adoption of railway electrification would result in a substantial general reduction in the cost of

electricity to the whole country, it is certainly not correct to suppose that railway electrification is necessary in order to justify the existence of the grid. Actually the adoption of railway electrification would result in a further expenditure on the grid of some £80,000,000, or over two and a half times the present expenditure. The advantageous effect of railway electrification on electric supply can therefore be regarded as an incidental advantage, and not the deciding factor. This also applies to the advantage of railway electrification from the point of view of creating employment, although, in view of the very considerable effect on employment which might result, the matter is of great importance.

The real deciding factors are, firstly, the magnitude of the traffic to be carried by the railways in the future, and, secondly, the fact—well established in other countries, and to some extent also in this country, on the Southern Railway—that electrification makes railway transport a more attractive proposition both from a commercial point of view and from the point of view of comfort and convenience for passenger traffic.

